

**UNITED STATES OF AMERICA  
DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION  
RENTON, WASHINGTON 98055-4056**

In the matter of the petition of

**The Boeing Company**

for exemption from §§ 25.562(b)(2),  
25.562(c)(5), and 25.562(c)(6), of Title 14, Code  
of Federal Regulations

**Regulatory Docket No. 29204**

**PARTIAL GRANT OF EXEMPTION**

By letter dated April 2, 1998, Mr. Walt Smith, Manager, MD-17 Airworthiness, The Boeing Company, 2401 E. Wardlow Rd., Long Beach, CA 90807-5309, petitioned the FAA for exemption from the following sections of Title 14, Code of Federal Regulations (14 CFR): the floor warpage test requirements of § 25.562(b)(2) for pilot and co-pilot seats, the Head Injury Criterion (HIC) test criteria of § 25.562(c)(5) for pilot and co-pilot seats (with regard to the Head-up Display (HUD) installation), and the femur compression test requirements of § 25.562(c)(6) for pilot, co-pilot, and observer seats, on MD-17 freighter aircraft.

**The petitioner requests relief from the following regulations:**

Section 25.562(b)(2), in prescribing the conditions under which seats must be tested, requires in pertinent part that where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least ten degrees vertically (i.e., out of parallel) with one rolled ten degrees.

Section 25.562(c)(5) requires that each occupant must be protected from serious head injury under the test conditions prescribed in § 25.562(b). Where head contact with structure can occur, protection must be provided so that the head impact does not exceed a HIC of 1,000 units defined by the following equation:

$$HIC = [(t_2 - t_1) \left[ \frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t) dt \right]^{2.5}]_{\max}$$

Section 25.562(c)(6) requires that, where leg injuries may result from contact with seats or other structure, under the test conditions prescribed in § 25.562(b), protection must be provided to prevent axially compressive loads exceeding 2,250 pounds in each femur.

#### **Related sections of the regulations:**

Section 25.785(b) requires that each seat, harness, and adjacent part of the airplane, at each station designated as occupiable during takeoff and landing, must be designed so that a person making proper use of those facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in §§ 25.561 and 25.562.

#### **The petitioner's supportive information is as follows:**

The Boeing Company, manufacturer of the model MD-17 freighter aircraft, hereby petitions for exemption from the requirements of §§ 25.562(b)(2), 25.562(c)(5), and 25.562(c)(6) for MD-17 airplanes.

“Substance of rule from which relief is sought:”

Section 25.562(b)(2) requires, in pertinent part, that “where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e., out of parallel) with one rolled 10 degrees.”

Section 25.562(c)(5) requires, in pertinent part, that “where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Injury Criterion (HIC) of 1,000 units.”

Section 25.562(c)(6) requires that where “leg injuries may result from contact with seats or other structure, protection must be provided to prevent axially compressive loads exceeding 2,250 pounds in each femur.”

“Nature and extent of relief sought:”

Section 25.562(b)(2): Relief is sought to allow dynamic testing of the pilot/co-pilot seats without the specified misalignment (floor warpage).

Section 25.562(c)(5): Relief is sought to remove HIC from the pass/fail requirements for dynamic testing of the pilot/co-pilot seats only.

Section 25.562(c)(6): Relief is sought to allow the use of rational analysis in lieu of actual dynamic testing for the pilot/co-pilot and observer seats.

“Description of aircraft covered:

“The MD-17 airplane is an all-cargo airplane designed to carry outsized and special cargo into short and/or austere fields, and will provide special cargo-delivery capabilities not available with any other airplane type certificated by the FAA.

“The MD-17 flight deck features two head-up displays (HUD) like those on the military C-17 counterpart on which its design is based. The HUD’s (existing design) serve as primary flight displays [PFD], and are required for MD-17 aircraft flight safety since they provide primary flight information in a heads-up environment. The MD-17 HUD is one of the features that combine to achieve excellent short-field landing performance and precise touchdown-on-aimpoint capability.

“Information provided in support of petition:”

The MD-17 is the first freighter aircraft that will be required to fully comply with § 25.562.

“Due to the unique design and mission requirements of the MD-17, compliance with certain provisions of § 25.562 would increase the cost of certification without a commensurate increase in safety. Some of these required provisions could impact the mission capability of the aircraft.”

In the interest of providing the public with a safe aircraft that incorporates the most crashworthy features as is reasonably practical, Boeing proposes to comply with § 25.562, except as follows:

Section 25.562(b)(2): The preamble to Amendment 25-64, which adopts § 25.562, states, “Crash investigations have shown that localized cabin floor deformation can occur in survivable crashes. This has been confirmed by the controlled impact demonstration [CID] and drop tests involving transport category airplanes. The inability of some seats to accommodate such

deformations, remain in place, and restrain the occupants can contribute significantly to the degree of injury during a crash. The simulated floor deformation used in the dynamic tests . . . will demonstrate the tolerance of the seat and its attachments to deformations that could occur in an actual crash.

“The preamble also states the benefit of this amendment is believed to be that, ‘. . . some lives are expected to be saved that otherwise may not have been.’ The test requirement of § 25.562(b)(2) makes no distinction between passenger and crew seats, while the evidence mentioned in the preamble is believed to be based on passenger seats only. There is evidence to suggest that floor warpage has not been a significant factor in flight deck seat failures during survivable crash conditions.

“Observations after accidents indicate that no flight deck seat separation problems have occurred on aircraft with 40 or more inches of frangible structure between the flight deck floor and the lower fuselage contour. The MD-17, like other large transport aircraft, has more than the minimum of 40 inches of frangible structure between the flight deck floor and fuselage contour.

“The FAA acknowledged in the preamble to Amendment 25-64 the likelihood that seats designed to meet this amendment would cost more to manufacture, and therefore to purchase, and would increase the airplane operating cost due to a weight increase. In order to justify the increased costs, it must be expected that some lives will be saved that otherwise may not have been. This does not appear to be the case for the MD-17 flight deck seats. These increased costs will create an economic disadvantage for the MD-17 without a commensurate expectation of saving lives that otherwise may have been lost.”

“Section 25.562(c)(5): Boeing realizes that there have been significant improvements in seat design since the implementation of § 25.562 requirements. These enhancements have allowed compliance with the majority of § 25.562 sections to become practical for newer aircraft; however, in spite of this progress, a comprehensive solution to the HIC requirements for flight crew seating has yet to be determined, i.e., a solution that considers the interests of all parties involved in the manufacture, installation, and operation of seats and aircraft.

“An exemption from the HIC requirement for flight crew seats is necessary to allow the retention of a dual HUD. Although the HUD installation is within the head strike area only under certain conditions of the dynamic test (i.e., the head clears except during the 0-degree yaw condition), the HUD is to be used as the PFD for all regimes of normal MD-17 operations. This HUD installation is identical to that on the U.S. Air Force C-17, and is a critical element to safe operation of the aircraft during short-field, precise-approach operations. The HUD is a requirement for MD-17 short-field operations, and is addressed in special conditions and a

Special Federal Aviation Regulation (SFAR). [imposed as part of the certification basis for the MD-17]”

The MD-17’s HUD, as PFD, provides the pilot with all pertinent flight information while retaining his focus outside the aircraft. This ability of the pilot to maintain focus outside the cockpit is a significant factor in overall aircraft safety. The MD-17’s HUD requires the pilot to be as close as practical to the HUD to maximize the field of view. Although this closeness may affect the MD-17’s ability to comply with the HIC requirements of § 25.562, the significant improvement in overall aircraft safety more than offsets this.

“Section 25.562(c)(6): Preliminary evaluations using computer simulations indicate that leg contact likely to impose femur loads (i.e., knee contact) will not occur for the occupants of the four flight deck seats. However, it is not possible to insure that leg contact will not occur without a full dynamic test.” This testing would require the construction and/or simulation of a nearly complete MD-17 cockpit, and would affect the schedule for the dynamic testing of these seats.

Industry testing has demonstrated that seats designed to meet the injury criteria prescribed in § 25.562 have never failed to comply with femur loading requirement (even when leg contact does occur) during testing programs.

“Therefore, since industry testing has not shown a safety benefit associated with this test, and since test set-up costs are high, Boeing requests an exemption from the femur-loading test requirements. In lieu of actual testing for femur loads, Boeing proposes to provide data and results of simulations using computer analysis, which will indicate that the design is unlikely to cause femur injury.

“It is Boeing’s position that the above-stated proposals for compliance with § 25.562 is consistent with rulings established for other transport aircraft that are in the process of receiving type certification. This position will provide a level playing field for all aircraft manufacturers with regard to the establishment of type certification bases.

“Reasons why granting an exemption is in the public interest:

“The MD-17 is a commercial derivative of the U.S. Air Force C-17A. The C-17A fleet of 37 aircraft has accumulated in excess of 70,000 flight hours, with an excellent safety record. The introduction of the MD-17, with its capability for carrying heavy and outsized cargo, and its unique short-field performance, will greatly benefit the public.” Today, the airlift of heavy and outsized cargo by freight forwarders and operators requires the use of foreign-registered aircraft not type certified to FAA safety standards. In fact, the safety and reliability record of one of the

competing aircraft is particularly poor, and it has been grounded several times. As an aircraft type certificated by the FAA, the MD-17 will provide a safer alternative.

“The economic benefits associated with the production of the MD-17 are also in the best interest of the public. The acquisition cost of the C-17A to the U.S. government would be reduced, because of the economic advantage of a production quantity increase of the C-17A aircraft. Improvements in overhead cost distribution and the production learning curve distribution are directly affected by introduction of the MD-17 into the production line. Furthermore, the MD-17 is designed for maximum commonality with the C-17A, and will enhance the Civil Reserve Aircraft Fleet (CRAF) potential at a lower cost to the U.S. government.”

Granting an exemption so that the MD-17 can be introduced will benefit the public by allowing the introduction of a safe alternative for air transport of heavy/outsized equipment serving two to three times as many airports as existing freighter aircraft, and will reduce acquisition costs (taxpayer burden) of the C-17.

“Additionally, domestic air carriers operating the MD-17 will increase revenue for the U.S., and will potentially establish early-entrant dominance in the emerging heavy/outsized cargo air transport industry. While the MD-17 remains unmatched in capability, this early-entrant advantage will enable the U.S. industry to better preempt the current and future entrants, e.g., the Russian AN-124, the Airbus Beluga, the Il-76, and the AN-70. Revenue will also be increased for the U.S., due to the potential for improved sales to foreign operators, which in turn improves the U.S. balance of payments.

“Granting an exemption will avoid an economic disadvantage for the MD-17, due to increased airplane purchase cost and increased operating costs. These additional costs would be incurred without a commensurate expectation of saving lives that otherwise may have been lost.”

Finally, granting an exemption is necessary to retain dual HUD's as PFD's, technology that is instrumental in the MD-17's ability to perform precise, short-field landings. The HUD installation is identical to that on the USAF C-17, and is critical to safe operation of the aircraft, given its unique operational environment.

A summary of Boeing's petition was published in the Federal Register on June 19, 1998 (63 FR 33755). No comments were received.

**The FAA's analysis/summary is as follows:**

Section 25.562(b)(2) floor warpage test requirements: Subsequent to the adoption of this requirement by Amendment 25-64, it was determined that, although some cockpit floor distortions have occurred during accidents, there has not been a problem with flight deck seat separations due to floor buckling on narrow body and larger airplanes having at least 40 inches of frangible structure between the flight deck floor and the extended lower fuselage contour. Consequently, the FAA has concluded that requiring the testing of flight deck seats under conditions of floor warpage cannot be justified on airplanes of this minimum size. The FAA is currently working toward amending § 25.562(b)(2) in this regard.

Section 25.562(c)(5) HIC requirements: Relevant arguments that may be considered by the FAA in evaluating an exemption are those specified in § 11.25(b)(5). This section requires a justification, if appropriate, as to why granting an exemption from the HIC requirements of § 25.562(c)(5) would not adversely affect safety, or how the petitioner would be providing a level of safety equal to that provided by § 25.562(c)(5). The petitioner has not provided any arguments in response to this requirement. Furthermore, there is no indication that the petitioner has even determined if a non-compliance condition exists, or if it does, the degree of non-compliance.

Section 11.25(b)(5) also requires a justification as to why it is in the public interest to grant an exemption from the HIC requirements of § 25.562(c)(5). The petitioner has not provided any arguments in direct response to this requirement. The petitioner has instead confined itself to a discussion of the importance, to the petitioner, of retaining the HUD's as PFD's to achieve certain airplane operating characteristics. The petitioner states that its HUD design precludes compliance with the HIC requirement. However, the FAA has previously certificated other HUD installations that did not affect such compliance. The petitioner has not indicated how the retention of the airplane's operational characteristics, and the compliance with HIC requirements, are mutually exclusive goals. An exemption from the HIC requirements of § 25.562(c)(5) shall not be granted unless the petitioner provides the Docket with convincing arguments why it is in the public interest that the flight crew of the proposed MD-17 airplane not be afforded the protection against head injury that compliance with § 25.562(c)(5) requires.

Section 25.562(c)(6) femur load requirements: The FAA is not aware of any instances where certification testing of flightcrew seating in this regard has resulted in non-compliance. Indeed, subsequent to adoption of this requirement, testing by the FAA's Civil Aeromedical Institute (CAMI) confirms an extremely low likelihood for a problem in this area. Accordingly, in view of this history, and taking into account the arguments advanced by the petitioner, the FAA favorably considers the petitioner's request in this regard. The FAA considers it prudent, however, while waiving the requirement for actual testing, that the petitioner analyze the

proposed configurations relative to those configurations which have been tested successfully, and document this analysis for FAA approval.

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest, and is determined not to have an adverse effect on the level of safety provided by the regulations. Therefore, pursuant to the authority contained in §§ 40113 and 44701, delegated to me by the Administrator (14 CFR § 11.53), the portion of Boeing's petition for exemption from the floor warpage test requirements of § 25.562(b)(2) for pilot and co-pilot seating, is granted. Additionally, exemption is granted from the femur compression test requirements only of § 25.562(c)(6), for pilot, co-pilot, and observer seating, providing that substantiation acceptable to the FAA is presented which will satisfactorily show compliance with the intent of this requirement.

With regard to the portion of Boeing's petition for exemption from the noted head injury requirements, I find that a grant of exemption is not in the public interest. Therefore, pursuant to the authority contained in §§ 40113 and 44701, delegated to me by the Administrator (14 CFR § 11.53), the portion of Boeing's petition for exemption from the HIC test criteria of § 25.562(c)(5) for pilot and co-pilot seating is hereby denied.

Issued in Renton, Washington, on October 1, 1998

/s/ Darrell M. Pederson

Darrell M. Pederson

Acting Manager

Transport Airplane Directorate

Aircraft Certification Service, ANM-100